

The documentation and process conversion measures necessary to comply with this revision shall be completed by 30 June 2013.

INCH-POUND

MIL-PRF-19500/697E
15 May 2013
SUPERSEDING
MIL-PRF-19500/697D
14 January 2011

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, FIELD EFFECT RADIATION HARDENED
(TOTAL DOSE AND SINGLE EVENT EFFECTS) TRANSISTOR, N-CHANNEL,
SILICON, TYPE 2N7478T1, JANTXVR, F, G, AND H AND JANSR, F, G, AND H

This specification is approved for use by all Departments
and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of
this specification sheet and MIL-PRF-19500.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for a N-channel, enhancement-mode, MOSFET, radiation hardened (total dose and single event effects, (SEE)), power transistor. Two levels of product assurance are provided for each device type as specified in MIL-PRF-19500, with avalanche energy maximum rating (E_{AS}) and maximum avalanche current (I_{AS}). See 6.5 for JANHC and JANKC die versions.

1.2 Physical dimensions. See figure 1, (TO-254AA).

1.3 Maximum ratings. $T_A = +25^\circ\text{C}$, unless otherwise specified.

| Type | P_T (1) $T_C = +25^\circ\text{C}$ | P_T $T_A = +25^\circ\text{C}$ | $R_{\theta JC}$ (2) | V_{DS} | V_{DG} | V_{GS} | I_{D1} (3) (4) $T_C = +25^\circ\text{C}$ | I_{D2} (3) (4) $T_C = +100^\circ\text{C}$ | I_S | I_{DM} (5) | T_J and T_{STG} |
|----------|--|------------------------------------|---|-------------------|-------------------|-------------------------|---|--|-------------------|----------------------|---|
| 2N7478T1 | <u>W</u> 208 | <u>W</u> 2.6 | <u>$^\circ\text{C}/\text{W}$</u> 0.60 | <u>V dc</u> 30 | <u>V dc</u> 30 | <u>V dc</u> ± 20 | <u>A dc</u> 45 | <u>A dc</u> 45 | <u>A dc</u> 45 | <u>A (pk)</u> 180 | <u>$^\circ\text{C}$</u> -55 to +150 |

- (1) Derate linearly 1.67 W/ $^\circ\text{C}$ for $T_C > +25^\circ\text{C}$.
- (2) See figure 2, thermal impedance curves.
- (3) The following formula derives the maximum theoretical I_D limit. I_D is limited by package and device construction to 45 A.

$$I_D = \sqrt{\frac{T_{JM} - T_C}{(R_{\theta JC}) \times (R_{DS(on)} \text{ at } T_{JM})}}$$

- (4) See figure 3, maximum drain current graph.
- (5) $I_{DM} = 4 \times I_{D1}$; I_{D1} as calculated by footnote (3).

* Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil/>.

AMSC N/A

FSC 5961

1.4 Primary electrical characteristics at $T_C = +25^\circ\text{C}$.

| Type | Min $V_{(BR)DSS}$ $V_{GS} = 0$ $I_D = 1.0 \text{ mA dc}$ | $V_{GS(TH)1}$ $V_{DS} \geq V_{GS}$ $I_D = 1.0 \text{ mA dc}$ | Max I_{DSS1} $V_{GS} = 0$ $V_{DS} = 80 \text{ percent}$ of rated V_{DS} | Max $r_{DS(on)} (1)$ $V_{GS} = 12 \text{ V}, I_D = I_{D2}$ | | E_{AS} |
|----------|--|--|--|---|----------------------------|-----------|
| | | | | $T_J = +25^\circ\text{C}$ | $T_J = +150^\circ\text{C}$ | |
| | <u>V dc</u> | <u>V dc</u> Min Max 2.0 4.0 | <u>$\mu\text{A dc}$</u> | <u>Ω</u> | <u>Ω</u> | <u>mJ</u> |
| 2N7478T1 | 30 | | 10 | 0.0045 | 0.009 | 1250 |

(1) Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

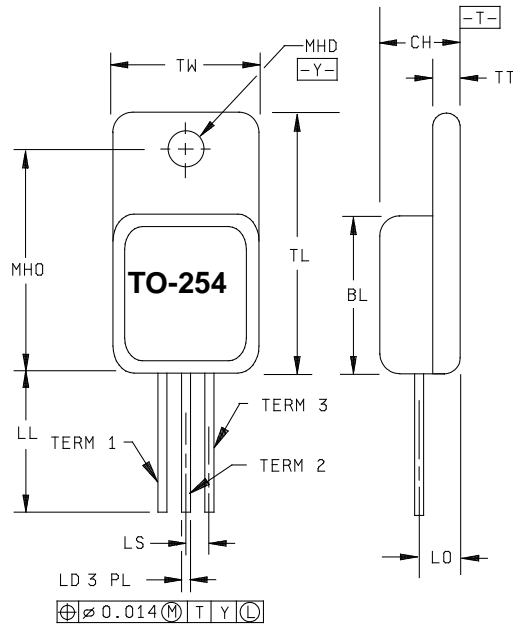
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 - Test Methods for Semiconductor Devices.

* (Copies of these documents are available online at <http://quicksearch.dla.mil/> or <https://assist.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.



| Ltr | Dimensions | | | | Notes |
|--------|------------|------|-------------|-------|-------|
| | Inches | | Millimeters | | |
| | Min | Max | Min | Max | |
| BL | .535 | .545 | 13.59 | 13.84 | |
| CH | .249 | .260 | 6.32 | 6.60 | |
| LD | .035 | .045 | 0.89 | 1.14 | |
| LL | .510 | .570 | 12.95 | 14.48 | 3 |
| LO | .150 BSC | | 3.81 BSC | | |
| LS | .150 BSC | | 3.81 BSC | | |
| MHD | .139 | .149 | 3.53 | 3.78 | |
| MHO | .665 | .685 | 16.89 | 17.40 | |
| TL | .790 | .800 | 20.07 | 20.32 | 4 |
| TT | .040 | .050 | 1.02 | 1.27 | |
| TW | .535 | .545 | 13.59 | 13.84 | 4 |
| Term 1 | Drain | | | | |
| Term 2 | Source | | | | |
| Term 3 | Gate | | | | |

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Protrusion thickness of ceramic eyelets included in dimension LL.
4. All terminals are isolated from case.
5. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 1. Dimensions and configuration, TO-254AA.

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500 and as follows:

I_{AS} - Rated avalanche current, nonrepetitive
nC - nano Coulomb

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500, and figure 1 (TO-254AA) herein. Methods used for electrical isolation of the terminals shall employ materials that contain a minimum of 90 percent Al_2O_3 (ceramic).

3.4.1 Lead formation and finish. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-PRF-19500 and herein. Where a choice of finish is desired, it shall be specified in the acquisition document (see 6.2). When lead formation is performed, as a minimum, the vendor shall perform 100 percent hermetic seal in accordance with screen 14 of MIL-PRF-19500 and 100 percent dc testing in accordance with table I, subgroup 2 herein.

3.5 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge protection.

3.5.1 Handling. MOS devices must be handled with certain precautions to avoid damage due to the accumulation of static charge. However, the following handling practices are recommended (see 3.5).

- a. Devices should be handled on benches with conductive handling devices.
- b. Ground test equipment, tools, and personnel handling devices.
- c. Do not handle devices by the leads.
- d. Store devices in conductive foam or carriers.
- e. Avoid use of plastic, rubber, or silk in MOS areas.
- f. Maintain relative humidity above 50 percent if practical.
- g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.
- h. Gate must be terminated to source, $R \leq$ or 100 k Ω , whenever bias voltage is applied drain to source.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I.

3.7 Electrical test requirements. The electrical test requirements shall be as specified in table I.

3.8 Marking. Marking shall be in accordance with MIL-PRF-19500. At the option of the manufacturer, marking of the country of origin may be omitted from the body of the transistor but shall be retained on the initial container.

3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4 and tables I and II).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table III tests, the tests specified in table III herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.2.1.1 SEE. Design capability shall be tested on the initial qualification and thereafter whenever a major die design or process change is introduced. See the design safe operation area figure. End-point measurements shall be in accordance with table II.

4.3 Screening (JANS and JANTXV). Screening shall be in accordance with table E-IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

| Screen (see table E-IV of MIL-PRF-19500) (1) (2) | Measurement | |
|---|--|---|
| | JANS | JANTXV |
| (3) | Gate stress test (see 4.3.1) | Gate stress test (see 4.3.1) |
| (3) | Method 3470 of MIL-STD-750, single pulse avalanche energy test (see 4.3.2) | Method 3470 of MIL-STD-750, single pulse avalanche energy test (see 4.3.2) |
| (3) 3c | Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3) | Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3) |
| 9 | Subgroup 2 of table I herein I_{DSS1} , I_{GSSF1} , I_{GSSR1} , as a minimum | Not applicable |
| 10 | Method 1042 of MIL-STD-750, test condition B | Method 1042 of MIL-STD-750, test condition B |
| 11 | I_{GSSF1} , I_{GSSR1} , I_{DSS1} , $r_{DS(ON)1}$, $V_{GS(TH)1}$ Subgroup 2 of table I herein. $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 10$ μ A dc or ± 100 percent of initial value, whichever is greater. | I_{GSSF1} , I_{GSSR1} , I_{DSS1} , $r_{DS(ON)1}$, $V_{GS(TH)1}$ Subgroup 2 of table I herein. |
| 12 | Method 1042 of MIL-STD-750, test condition A | Method 1042 of MIL-STD-750, test condition A |
| 13 | Subgroups 2 and 3 of table I herein, $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 10$ μ A dc or ± 100 percent of initial value, whichever is greater. $\Delta r_{DS(ON)1} = \pm 20$ percent of initial value. $\Delta V_{GS(TH)1} = \pm 20$ percent of initial value. | Subgroup 2 of table I herein, $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 10$ μ A dc or ± 100 percent of initial value, whichever is greater. $\Delta r_{DS(ON)1} = \pm 20$ percent of initial value. $\Delta V_{GS(TH)1} = \pm 20$ percent of initial value. |
| 17 | Method 1081 of MIL-STD-750 (see 4.3.5), Endpoints: Subgroup 2 of table I herein. | Method 1081 of MIL-STD-750 (see 4.3.5), Endpoints: Subgroup 2 of table I herein. |

(1) At the end of the test program, I_{GSSF1} , I_{GSSR1} , and I_{DSS1} are measured.

(2) An out-of-family program to characterize I_{GSSF1} , I_{GSSR1} , I_{DSS1} , and $V_{GS(th)1}$ shall be invoked.

* (3) Shall be performed any time after temperature cycling, screen 3a; JANTX and JANTXV levels do not need to be repeated in screening requirements.

MIL-PRF-19500/697E

4.3.1 Gate stress test. Apply $V_{GS} = 24 \text{ V}$, minimum for $t = 250 \text{ } \mu\text{S}$, minimum.

4.3.2 Single pulse avalanche energy (E_{AS}).

- a. Peak current $I_{AS} = I_{D1}$.
- b. Inductance $L = \left[\frac{2E_{AS}}{(I_{D1})^2} \right] \left[\frac{V_{BR} - V_{DD}}{V_{BR}} \right] \text{ mH minimum.}$
- c. Gate to source resistor R_{GS} $25 \text{ } \Omega \leq R_{GS} \leq 200 \text{ } \Omega$.
- d. Supply voltage $V_{DD} = 25 \text{ V dc.}$
- e. Initial case temperature $T_C = +25^\circ \text{ C, } -5^\circ \text{ C, } +10^\circ \text{ C.}$
- f. Gate voltage $V_{GS} = 12 \text{ V dc.}$
- g. Number of pulses to be applied 1 pulse minimum.

4.3.3 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3161 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , t_H , t_{SW} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μS max. See table III, group E, subgroup 4 herein.

* 4.3.4 Dielectric withstanding voltage.

- a. Magnitude of test voltage 900 V dc.
- b. Duration of application of test voltage 15 seconds (min).
- c. Points of application of test voltage All leads to case (bunch connection).
- d. Method of connection Mechanical.
- e. Kilovolt-ampere rating of high voltage source 1,200V / 1.0 mA (min).
- f. Maximum leakage current 1.0 mA.
- g. Voltage ramp up time 500V / second.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table E-V of MIL-PRF-19500 and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIA (JANS) and table E-VIB (JANTXV) of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

* 4.4.2.1 Group B inspection, table E-VIA (JANS) of MIL-PRF-19500.

| <u>Subgroup</u> | <u>Method</u> | <u>Condition</u> |
|-----------------|---------------|--|
| B3 | 1051 | Test condition G, 100 cycles. |
| B3 | 2077 | SEM (scanning electron microscope). |
| * B4 | 1042 | Intermittent operation life, condition D. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. $t_{on} = 30$ seconds minimum. |
| B5 | 1042 | Accelerated steady-state gate bias, condition B, $V_{GS} = \text{rated}$; $T_A = +175^\circ\text{C}$, $t = 24$ hours minimum; or $T_A = +150^\circ\text{C}$, $t = 48$ hours minimum. |
| B5 | 1042 | Accelerated steady-state reverse bias, condition A, $V_{DS} = \text{rated}$; $T_A = +175^\circ\text{C}$, $t = 120$ hours minimum; or $T_A = +150^\circ\text{C}$, $t = 240$ hours minimum. |
| B5 | 2037 | Bond strength, test condition A. |

* 4.4.2.2 Group B inspection, table E-VIB (JANTXV) of MIL-PRF-19500.

| <u>Subgroup</u> | <u>Method</u> | <u>Condition</u> |
|-----------------|---------------|---|
| B2 | 1051 | Test condition G, 25 cycles. |
| * B3 | 1042 | Intermittent operation life, condition D. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. $t_{on} = 30$ seconds minimum. |

* 4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

| <u>Subgroup</u> | <u>Method</u> | <u>Condition</u> |
|-----------------|---------------|---|
| C2 | 2036 | Test condition A; weight = 10 pounds; $t = 15$ s. |
| C5 | 3161 | See 4.3.3, $R_{\theta JC} = 0.60^\circ\text{C/W}$. |
| * C6 | 1042 | Intermittent operation life, condition D. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. $t_{on} = 30$ seconds minimum. |

4.4.4 Group D inspection. Group D inspection shall be conducted in accordance with table E-VIII of MIL-PRF-19500 and table II herein.

4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

TABLE I. Group A inspection.

| Inspection <u>1</u> / | MIL-STD-750 | | Symbol | Limits | | Unit |
|--|-------------|--|-----------------|--------|--------|-------|
| | Method | Condition | | Min | Max | |
| <u>Subgroup 1</u> | | | | | | |
| Visual and mechanical inspection | 2071 | | | | | |
| <u>Subgroup 2</u> | | | | | | |
| Thermal impedance <u>2</u> / | 3161 | See 4.3.3 | $Z_{\theta JC}$ | | | °C/W |
| Breakdown voltage drain to source | 3407 | $V_{GS} = 0$, $I_D = 1$ mA dc, bias condition C | $V_{(BR)DSS}$ | 30 | | V dc |
| Gate to source voltage (threshold) | 3404 | $V_{DS} \geq V_{GS}$, $I_D = 1$ mA dc | $V_{GS(TH)1}$ | 2.0 | 4.0 | V dc |
| Gate current | 3411 | $V_{GS} = +20$ V dc, bias condition C, $V_{DS} = 0$ | I_{GSSF1} | | +100 | nA dc |
| Gate current | 3411 | $V_{GS} = -20$ V dc, bias condition C, $V_{DS} = 0$ | I_{GSSR1} | | -100 | nA dc |
| Drain current | 3413 | $V_{GS} = 0$, bias condition C, $V_{DS} = 80$ percent of rated V_{DS} , | I_{DSS1} | | 10 | μA dc |
| Static drain to source on-state resistance | 3421 | $V_{GS} = 12$ V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$ | $r_{DS(ON)1}$ | | 0.0045 | Ω |
| Forward voltage | 4011 | $V_{GS} = 0$, condition A, pulsed (see 4.5.1), $I_D = I_{D1}$ | V_{SD} | | 1.2 | V dc |
| <u>Subgroup 3</u> | | | | | | |
| High temperature operation | | $T_C = T_J = +125^\circ\text{C}$ | | | | |
| Gate current | 3411 | $V_{GS} = \pm 20$ V dc, bias condition C, $V_{DS} = 0$ | I_{GSS2} | | ±200 | nA dc |
| Drain current | 3413 | $V_{GS} = 0$, bias condition C, $V_{DS} = 80$ percent of rated VDS | I_{DSS2} | | 25 | μA dc |
| Static drain to source on-state resistance | 3421 | $V_{GS} = 12$ V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$ | $r_{DS(ON)2}$ | | 0.008 | Ω |
| Gate to source voltage (threshold) | 3404 | $V_{DS} \geq V_{GS}$, $I_D = 1$ mA dc | $V_{GS(TH)2}$ | 1.0 | | V dc |
| Low temperature operation | | $T_C = T_J = -55^\circ\text{C}$ | | | | |
| Gate to source voltage (threshold) | 3404 | $V_{DS} \geq V_{GS(TH)3}$, $I_D = 1$ mA dc | $V_{GS(TH)3}$ | | 5.0 | V dc |

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

| Inspection <u>1/</u> | MIL-STD-750 | | Symbol | Limits | | Unit |
|---|-------------|---|--------------|--------|-----|------|
| | Method | Condition | | Min | Max | |
| <u>Subgroup 4</u> | | | | | | |
| Forward transconductance | 3475 | $I_D = I_{D2}$, $V_{DD} = 15$ V dc (see 4.5.1) | g_{FS} | 73 | | S |
| Switching time test | 3472 | $I_D = I_{D1}$, $V_{GS} = 12$ V dc; $R_G = 2.35 \Omega$, $V_{DD} = 50$ percent of rated V_{DS} | | | | |
| Turn-on delay time | | | $t_{D(on)}$ | | 35 | ns |
| Rise time | | | t_r | | 175 | ns |
| Turn-off delay time | | | $t_{D(off)}$ | | 80 | ns |
| Fall time | | | t_f | | 40 | ns |
| <u>Subgroup 5</u> | | | | | | |
| Safe operating area test (high voltage) | 3474 | See figure 4 $t_p = 10$ ms min. $V_{DS} = 80$ percent of max. rated V_{DS} | | | | |
| Electrical measurements | | See table I, subgroup 2 | | | | |
| <u>Subgroup 6</u> | | | | | | |
| Not applicable | | | | | | |
| <u>Subgroup 7</u> | | | | | | |
| Gate charge | 3471 | Condition B. $I_D = I_{D1}$, $V_{GS} = 12$ V dc, $V_{DD} = 50$ percent of rated V_{DS} | | | | |
| On-state gate charge | | | $Q_{G(ON)}$ | | 240 | nC |
| Gate to source charge | | | Q_{GS} | | 60 | nC |
| Gate to drain charge | | | Q_{GD} | | 55 | nC |
| Reverse recovery time | 3473 | $di/dt = -100$ A/ μ s, $V_{DD} \leq 30$ V, $I_D = I_{D1}$, | t_{rr} | | 140 | ns |

1/ For sampling plan, see MIL-PRF-19500.

2/ This test required for the following end-point measurements only:

- Group B, subgroups 3 and 4 (JANS).
- Group B, subgroups 2 and 3 (JANTXV).
- Group C, subgroups 2 and 6.
- Group E, subgroup 1.

TABLE II. Group D inspection.

| Inspection <u>1/ 2/ 3/</u> | MIL-STD-750 | | Symbol | Pre-irradiation limits | | Post-irradiation limits | | | | Unit |
|---|-------------|--|----------------------|------------------------|------|-------------------------|------|-------------|------|-------|
| | Method | Conditions | | R, F, G, and H | | R, F, and G | | H <u>4/</u> | | |
| | | | | Min | Max | Min | Max | Min | Max | |
| <u>Subgroup 1</u> Not applicable | | | | | | | | | | |
| <u>Subgroup 2</u> Steady-state total dose irradiation (V _{GS} bias) <u>5/</u> | 1019 | T _C = + 25°C V _{GS} = 12 V V _{DS} = 0 | | | | | | | | |
| Steady-state total dose irradiation (V _{DS} bias) <u>5/</u> | 1019 | V _{GS} = 0 V _{DS} = 80 percent of rated V _{DS} (pre-irradiation) | | | | | | | | |
| End-point electricals | | | | | | | | | | |
| Breakdown voltage, drain to source | 3407 | V _{GS} = 0 I _D = 1 mA bias condition C | V _{(BR)DSS} | 30 | | 30 | | 30 | | V dc |
| Gate to source voltage (threshold) | 3404 | V _{DS} ≥ V _{GS} I _D = 1 mA | V _{GS(th)1} | 2.0 | 4.0 | 2.0 | 4.0 | 1.5 | 4.0 | V dc |
| Gate current | 3411 | V _{GS} = +20 V V _{DS} = 0 bias condition C | I _{GSSF1} | | 100 | | 100 | | 100 | nA dc |
| Gate current | 3411 | V _{GS} = -20 V V _{DS} = 0 bias condition C | I _{GSSR1} | | -100 | | -100 | | -100 | nA dc |
| Drain current | 3413 | V _{GS} = 0 V _{DS} = 80 percent of rated V _{DS} (pre-irradiation) bias condition C | I _{DSS} | | 10 | | 10 | | 25 | μA dc |

See footnotes at end of table.

TABLE II. Group D inspection - Continued.

| Inspection 1/ 2/ 3/ | MIL-STD-750 | | Symbol | Pre-irradiation limits | | Post-irradiation limits | | | | Unit |
|---|-------------|---|---------------------|------------------------|--------|-------------------------|--------|------|-------|------|
| | Method | Conditions | | R, F, G, and H | | R, F, and G | | H 4/ | | |
| | | | | Min | Max | Min | Max | Min | Max | |
| <u>Subgroup 2</u> - Continued. | | | | | | | | | | |
| Static drain to source on-state voltage | 3405 | V _{GS} = 12 V I _D = I _{D2} Condition A, pulsed (see 4.5.1) | V _{DS(on)} | | 0.2025 | | 0.2025 | | 0.225 | V dc |
| Forward voltage source drain diode | 4011 | V _{GS} = 0 I _D = I _{D1} bias condition C | V _{SD} | | 1.2 | | 1.2 | | 1.2 | V dc |

1/ For sampling plan see MIL-PRF-19500.

2/ Group D qualification may be performed prior to lot formation. Wafers qualified to these group D QCI requirements may be used for any other specification sheet utilizing the same die design.

3/ At the manufacturer's option, group D samples need not be subjected to the screening tests, and may be assembled in its qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.

4/ The "H" designation represents devices which pass end-points at R, F, G, and H designated total-ionizing-dose (TID).

5/ Separate samples shall be pulled for each bias.

TABLE III. Group E inspection (all quality levels) for qualification or re-qualification only.

| Inspection | MIL-STD-750 | | Sample plan |
|--|-------------|--|---------------------|
| | Method | Conditions | |
| <u>Subgroup 1</u> | | | 45 devices c = 0 |
| Temperature cycling | 1051 | Test condition G, 500 cycles | |
| Hermetic seal | 1071 | As applicable | |
| Fine leak | | | |
| Gross leak | | | |
| Electrical measurements | | Table I, subgroup 2 herein. | |
| <u>Subgroup 2 1/</u> | | | 45 devices c = 0 |
| Steady-state reverse bias | 1042 | Condition A, 1,000 hours. | |
| Electrical measurements | | Table I, subgroup 2 herein. | |
| Steady-state gate bias | 1042 | Condition B, 1,000 hours. | |
| Electrical measurements | | Table I, subgroup 2 herein. | |
| <u>Subgroup 4</u> | | | Sample size N/A |
| Thermal impedance curves | | See MIL-PRF-19500. | |
| <u>Subgroup 10</u> | | | 22 devices c = 0 |
| Commutating diode for safe operating area test procedure for measuring dv/dt during reverse recovery of power MOSFET transistors or insulated gate bipolar transistors | 3476 | Test conditions shall be derived by the manufacturer | |
| <u>Subgroup 11</u> | | | |
| SEE 2/ 3/ | 1080 | See MIL-STD-750 method 1080 and 6.2. | 3 devices |

1/ A separate sample may be pulled for each test condition.

2/ Group E qualification of SEE effect testing may be performed prior to lot formation. Qualification may be extended to other specification sheets utilizing the same structurally identical die design.

3/ Device qualification to a higher level LET is sufficient to qualify all lower level LETs.

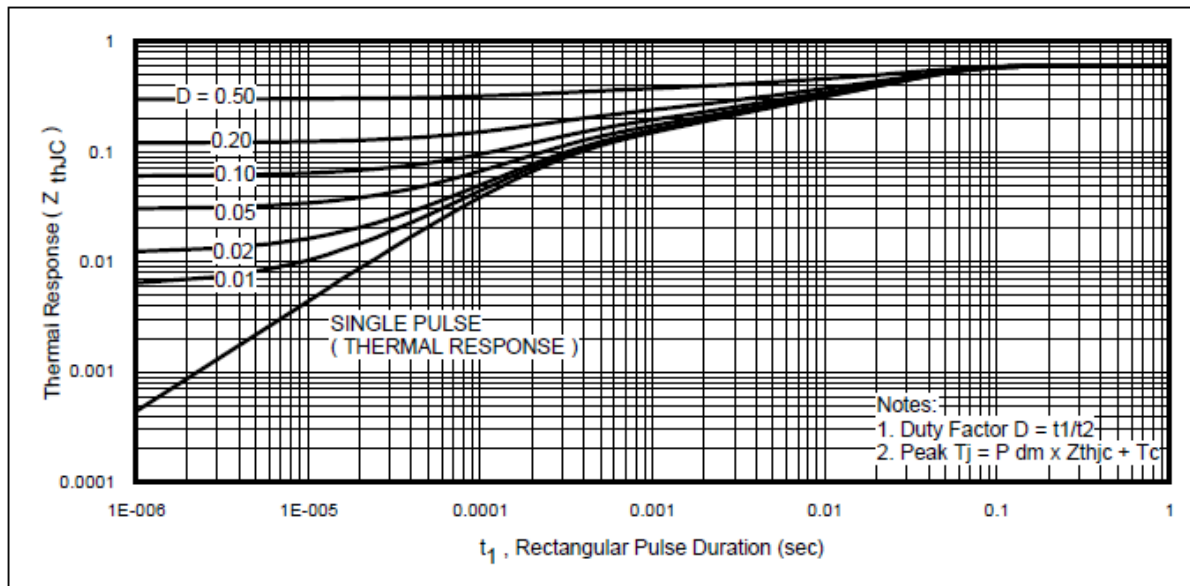


FIGURE 2. Thermal impedance curve.

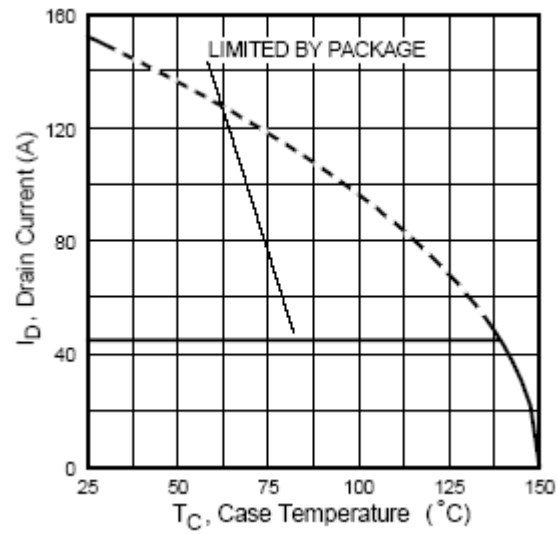


FIGURE 3. Maximum drain current versus case temperature graph.

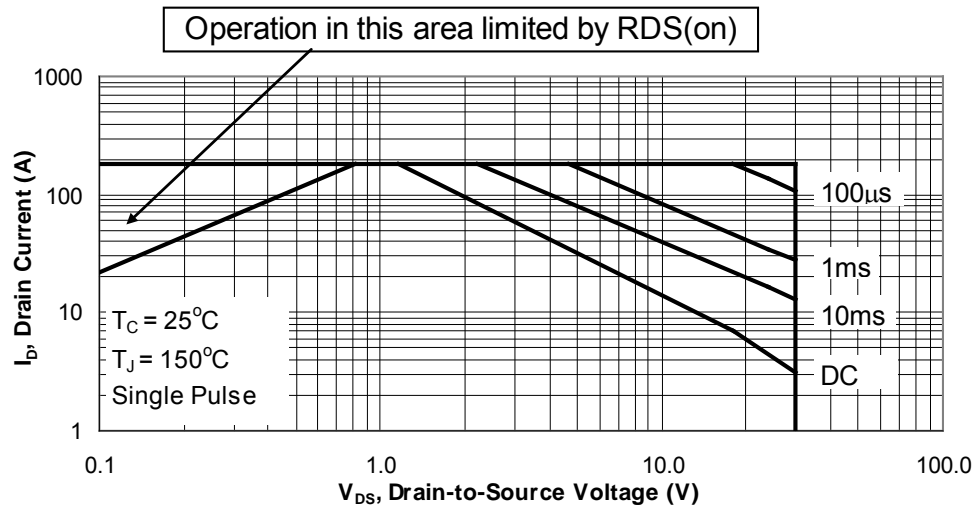


FIGURE 4. Safe operating area graph (2N7478T1).

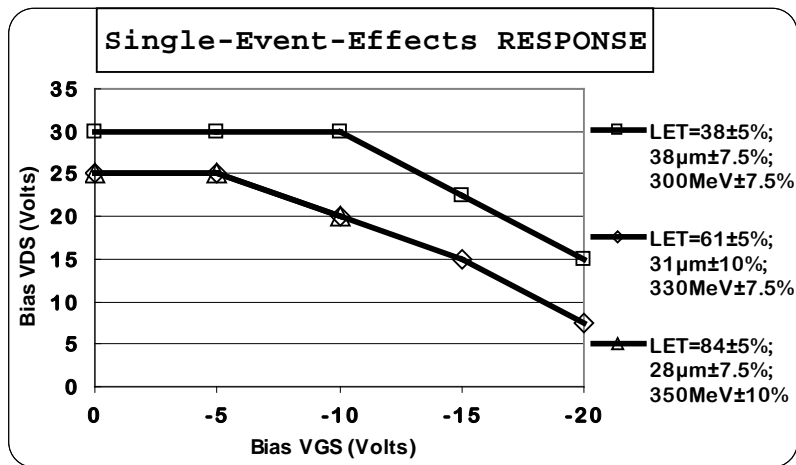


FIGURE 5. SEE safe operating area graph (2N7478T1).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of material is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in MIL-PRF-19500 are applicable to this specification.)

6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead formation and finish (see 3.4.1).
- d. Product assurance level and type designator.
- * e. For acquisition of RHA designated devices, table II, subgroup 1 testing of group D herein is optional. If subgroup 1 is desired, it should be specified in the contract.
- * f. If specific SEE characterization conditions are desired (see 6.6 and table IV), manufacturer's cage code should be specified in the contract or order.
- * g. If SEE testing data is desired, it should be specified in the contract or order.

* 6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.dla.mil>.

6.4 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying Number (PIN). This information in no way implies that manufacturer's PINs are substitutable for the military PIN.

| Preferred types military PIN | Commercial PIN |
|---------------------------------|----------------|
| 2N7478T1 | IRHMS57Z60 |

6.5 JANC die versions. The JANHC and JANKC die versions of these devices are covered under specification sheet MIL-PRF-19500/741.

* 6.6 Application data.

- * 6.6.1 Manufacturer specific irradiation data. Each manufacturer qualified to this slash sheet has characterized its devices to the requirements of MIL-STD-750 method 1080 and as specified herein. Since each manufacturer's characterization conditions can be different and can vary by the version of method 1080 qualified to, the MIL-STD-750 method 1080 revision version date and conditions used by each manufacturer for characterization have been listed here (see table IV) for information only. SEE conditions and figures listed in section 6 are current as of the date of this specification sheet, please contact the manufacturer for the most recent conditions.

* TABLE IV. Manufacturers characterization conditions.

| Manufactures CAGE | Inspection | MIL-STD-750 | | Sample plan |
|---|---|-------------|---|----------------|
| | | Method | Conditions | |
| 69210 (Applicable to devices with a date code of February 2009 and older) | SEE <u>1/</u> | 1080 | See figure 5. IGSSF1, IGSSR1, and IDSS1 in accordance with table I, subgroup 2 Fluence = 3E5 ±20 percent ions/cm2 Flux = 2E3 to 2E4 ions/cm2/sec, temperature = 25 ±5°C Surface LET = 38 MeV-cm2/mg ±5%, range = 38 μm ±7.5%, energy = 300 MeV ±7.5% In-situ bias conditions: VDS = 30 V and VGS = -10 V, VDS = 22.5 V and VGS = -15 V, VDS = 15 V and VGS = -20 V, (nominal 3.86 MeV/nucleon at Brookhaven National Lab Accelerator) Surface LET = 61 MeV-cm2/mg ±5%, range = 31 μm, ±10%, energy = 330 MeV ±7.5% In-situ bias conditions: VDS = 25 V and VGS = -5 V, VDS = 20 V and VGS = -10 V, VDS = 15 V and VGS = -15 V, VDS = 7.5 V and VGS = -20 V, (nominal 2.92 MeV/nucleon at Brookhaven National Lab Accelerator) Surface LET = 84 MeV-cm2/mg ±5%, range = 28 μm ±7.5%, energy = 350 MeV ±7.5% In-situ bias conditions: VDS = 25 V and VGS = -5 V, VDS = 20 V and VGS = -10 V, (nominal 1.98 MeV/nucleon at Brookhaven National Lab Accelerator) IGSSF1, IGSSR1, and IDSS1 in accordance with table I, subgroup 2 | 3 devices |
| | Electrical Measurements <u>2/</u> | | | |
| Upon qualification, all manufacturers shall provide the verification test conditions to be added to this table. | | | | |

1/ IGSSF1, IGSSR1, and IDSS1 was examined before and following SEE irradiation to determine acceptability for each bias condition. Other test conditions in accordance with table I, subgroup 2, may be performed at the manufacturer's option.

6.6 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

Army - CR
Air Force - 85
NASA - NA
DLA - CC

Preparing activity:

DLA - CC

(Project 5961-2013-010)

Review activity:

Army - MI
Air Force - 71, 99

* NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil/>.